Interactive comment on "Warming and ocean acidification may decrease estuarine dissolved organic carbon export to the ocean" by Michelle N. Simone et al.

Anonymous Referee #2 Received and published: 27 November 2020

Review of bg-2020-335 Warming and ocean acidification may decrease estuarine dissolved organic carbon export to the ocean Michelle N. Simone, Kai G. Schulz, Joanne M. Oakes, and Bradley D. Eyre

"This is a well described experimental case study that contributes to close an important knowledge gap concerning the modification of the carbon cycle under global environmental and climatic change. My biggest concern in the study is the upscaling to the global dimension. The authors are aware of the associated risks and that such an upscaling may be (at least) quantitatively quite problematic. Overall, this is a thoroughly made study and a useful addition in the field.

Suggestions for a revised manuscript:"

Comment: Section 4.3.3: The authors are correct in being very careful when they provide a daring global upscaling here. It would be good to add a paragraph on detailing why such an upscaling can be risky and possibly incorrect (different hydrodynamic settings, different sediment composition, different delivery of dissolved and particulate matter from land and through aeolian deposition, etc.)

Reply: We agree. This section is highly speculative and is purely an exercise of interest, a likely exercise that readers will do on their own. We will follow Reviewer 2's suggestion and add further details regarding the limitations of the upscaling. Also, see our reply to Reviewer 1's comments.

Comment: Line 54: It is not only the climate project models but rather the scenarios used for the projections. The scenarios are usually produced through simplified climate models and integrated assessment models.

Reply: Yes, this is true. We had included the scenario reference at the end of the sentence (RCP8.5), however, it would be more forthcoming to include the "high-emission scenario climate projections" explicitly in the text. This adjustment will be added. "Climate projection models under a high-emission scenario suggest that atmospheric CO_2 concentrations could more than double by the end of the century, increasing the partial pressure of CO_2 (pCO_2) in surface waters to 1000 μatm and decreasing pH by 0.3 units, together termed ocean acidification (OA) (RCP8.5, IPCC, 2019)."

Comment: Line 55: "increasing the partial pressure by 580 ppm" – relative to which reference year?

Reply: This has been rewritten for clarity. LN 54: "Climate projection models suggest that atmospheric CO_2 concentrations could more than double by the end of the century, increasing the partial pressure of CO_2 (pCO_2) in surface waters to 1000 μatm …"

Comment: Lines 55-60: Though regional primary production may be enhanced with temperature and pCO_2, climate change can lead to increased stratification and a decrease of mixing as well. It would be good to also discuss this aspect and cite a few relevant literature sources.

Reply: This discussion of the possible effect of stratification will be added to the discussion section with the following text in section4.3 (Warming drives increased heterotrophy and DOC assimilation): "Although it is yet to be assessed directly, the enhancement of primary production from temperature and pCO_2 may be counteracted by a potential increase in stratification with the changing climate (Li et al., 2020). Increased stratification has the potential to decrease nutrient supply to primary producers, despite increased light availability (Rost et al., 2008). However, this stratification is more likely to impact phytoplankton in oligotrophic waters rather than benthic microalgae which are in direct contact with remineralised nutrient supplied from within sediments."

Comment: Line 140: "refit from Mehrbach et al. (1973)" – can you describe in more detail how and why you did this?

Reply: We did not do the refit, Dickson and Millero (1987) did. The sentence reads, "Total borate concentrations (Uppström, 1974) and boric acid (Dickson, 1990) and stoichiometric equilibrium constants for carbonic acid (Dickson and Millero, 1987), refit from Mehrbach et al. (1973), were used." We just wanted to include the original source of Dickson and Millero (1987). For clarity, this has been rewritten as "…carbonic acid from Mehrbach et al. (1973) as refit by Dickson and Millero (1987), were used."

Comment: Line 277: "OA alone (at ambient temperatures)" – what is meant with 'ambient temperatures' exactly?

Reply: At ambient temperatures was meant to distinguish the OA scenario from the OA and temperature manipulation scenarios. This would therefore be at 23 °C. This sentence would be improved with the addition of the temperature included. LN 277 will now read, "OA alone (at mean ambient temperatures, 23 °C)"

Comment: Section headings "4.2 OA increases DOC uptake" and "4.3.2 Warming increases respiration and DOC uptake" are unclear. Which component takes up DOC? Maybe use a different word for 'uptake'?

Reply: We can see the ambiguity in uptake. We believe assimilation would be a more accurate term as the heterotrophs in the sediments actively assimilate DOC. The section headings will now read: "4.2 OA increases DOC assimilation" and "4.3 Warming drives increased heterotrophy and DOC assimilation"

Comment: Figure 1: Some fonts are so tiny that they are not readable. Please, increase them if relevant or delete unnecessary information.

Reply: This will be adjusted as suggested.

Comment: Figure 5: The 'bars' within the grey and dotted areas of the plot are barely visible. What do these 'bars' show? Please, provide information in the figure caption.

Reply: The figure has been redesigned. The figure caption will clearly indicate "Light (grey boxes) and dark fluxes (spotted boxes) of DOC (μmol-C m^{-2} h^{-1}) for (b) current-pCO_2 and (c) high-pCO_2 conditions."

References

Dickson, A. G., and Millero, F. J.: A comparison of the equilibrium constants for the dissociation of carbonic acid in seawater media, Deep Sea Research Part A. Oceanographic Research Papers, 34, 1733-1743, doi: 10.1016/0198-0149(87)90021-5, 1987.
Dickson, A. G.: Thermodynamics of the dissociation of boric acid in potassium chloride solutions from 273.15 to 318.15 K, J. Chem. Eng. Data., 35, 253-257, doi: 10.1021/je00061a009, 1990.
IPCC: Special Report on the Ocean and Cryosphere in a Changing Climate, 2019.
Li, G., Cheng, L., Zhu, J., Trenberth, K. E., Mann, M. E., and Abraham, J. P.: Increasing ocean stratification over the past half-century, Nature Climate Change, 10, 1116-1123, doi: 10.1038/s41558-020-00918-2, 2020.
Mehrbach, C., Culberson, C. H., Hawley, J. E., and Pytkowicx, R. M.: Measurement of the Apparent Dissociation Constants of Carbonic Acid in Seawater at Atmospheric Pressure, Limnol. Oceanogr., 18, 897-907, doi: 10.4319/lo.1973.18.6.0897, 1973.
Rost, B., Zondervan, I., and Wolf-Gladrow, D.: Sensitivity of phytoplankton to future changes in ocean carbonate chemistry: Current knowledge, contradictions and research directions, Marine Ecology-progress Series - MAR ECOL-PROGR SER, 373, 227-237, doi: 10.3354/meps07776, 2008.
Uppström, L. R.: The boron/chlorinity ratio of deep-sea water from the Pacific Ocean, Deep Sea Research and Oceanographic Abstracts, 1974, 161-162,